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(56) Documents cited  
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(54) Measuring delays in a packet transmission system

(57) A packet transmission system comprises a network of one or more nodes (1) Fig. 1, (not shown), each comprising a number of inputs 3, 3' connected via packet switching means to a number of outputs 4, 4', each of which has storage means 11, 11' associated with it in which to store a queue of packets to be outputted; and is characterised in that each node (1) is provided with timer means 14 to measure the time each packet spends in a queue of said storage means 11, 11'; and stamping means 12 to add to a time stamp field (TS) Fig. 4, (not shown), of each packet header before it is outputted from the node, the time the packet has spent in a queue as measured by the timer means 14.

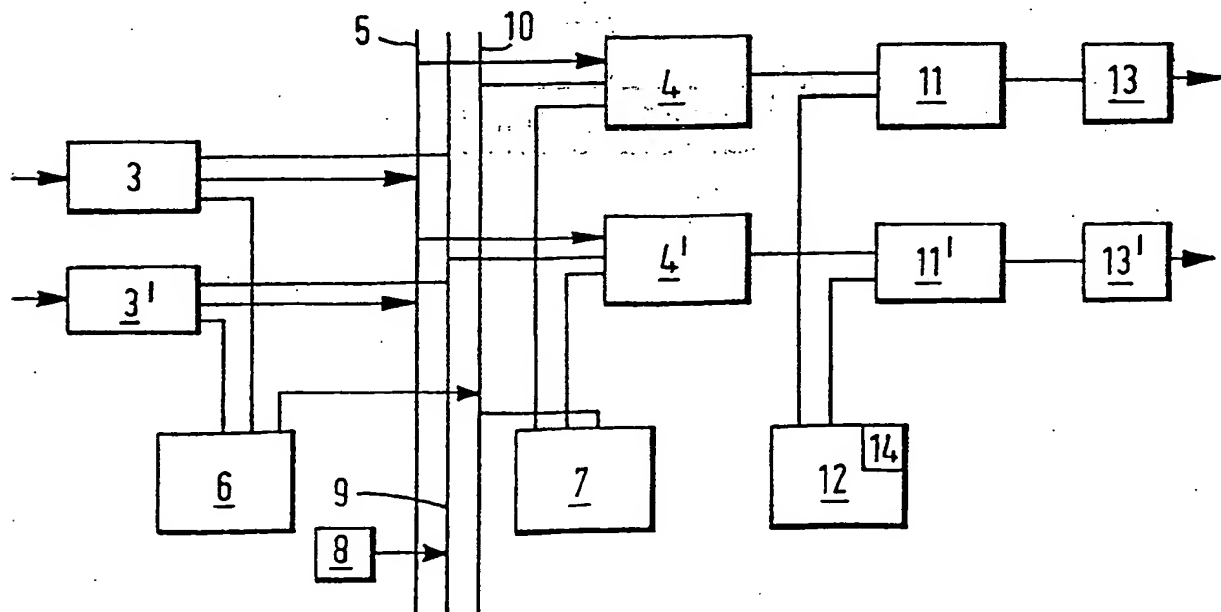


FIG. 2.

$i/2$

FIG. 1.

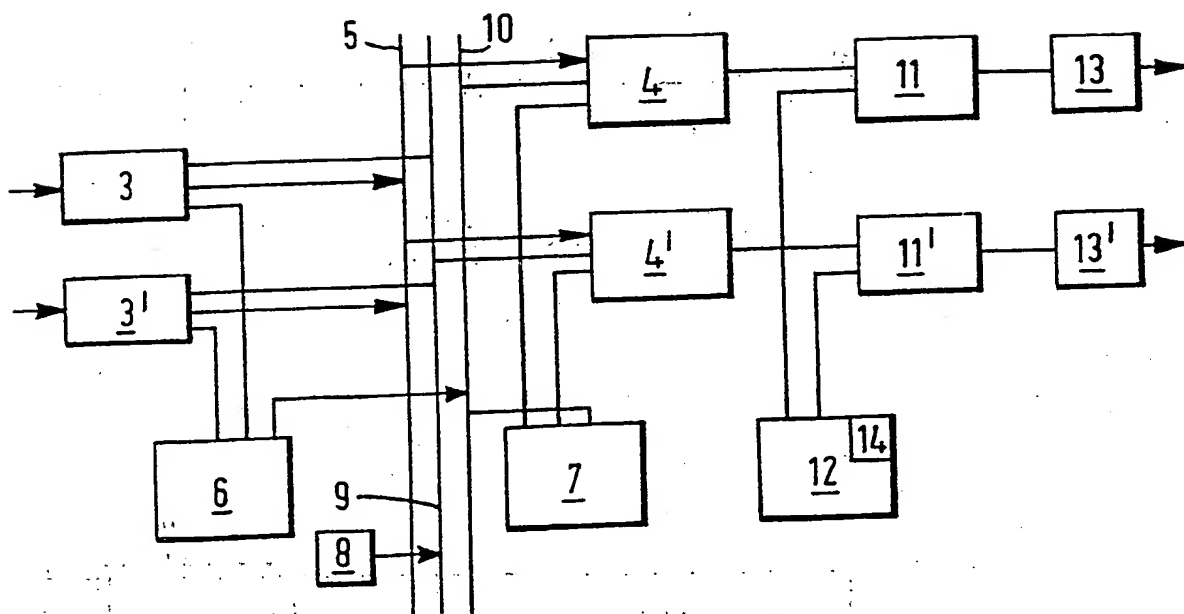
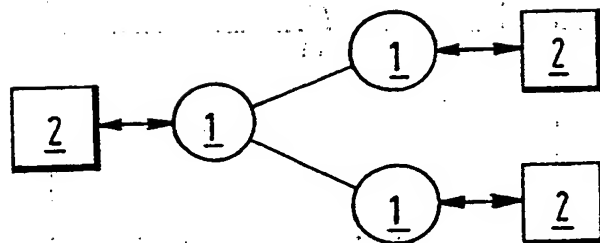


FIG. 2.

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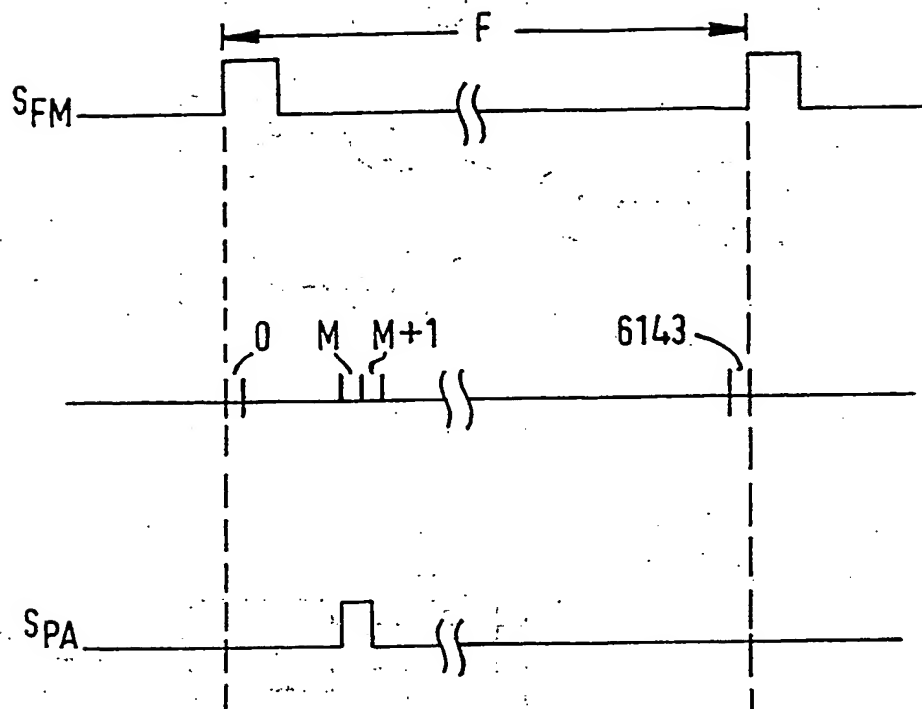


FIG.3.

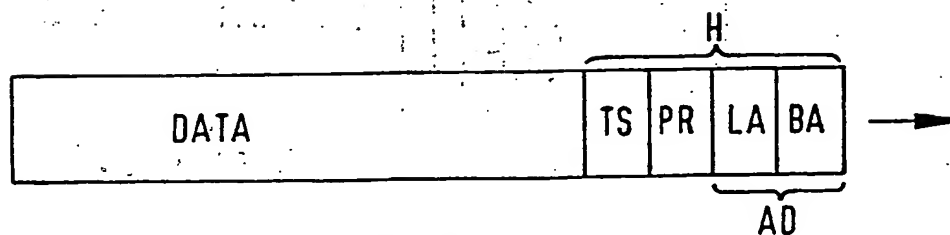


FIG.4.

## PACKET TRANSMISSION SYSTEM

### Technical Field

This invention relates to a packet transmission system and a method of measuring the delays of packets in such a system.

It is known in a packet switching system to provide each packet with a time stamp field in which to record delays incurred as the packet traverses the system. In particular, it is known to measure the variable time taken by each packet to traverse each node of a packet switching network and to add this time to the time stamp field. Delays across the node are caused by queuing of the packets in storage means and are random in nature. The time stamp field therefore records an accumulated value of the variable delay in traversing the network, this being an especially important parameter when packets are used to transmit voiceband information, the received quality of which deteriorates unacceptably unless some form of variable delay compensation is provided.

In one known system, two time stamp fields are employed, one for the accumulated delay and the

other for the arrival time of the packet at a node input. These values are then used with the time that the packet is outputted from the node to update the accumulated delay stamp field. In another known system, only one time stamp field is employed and this is updated both at the input and output of the node by subtracting the current value in the time stamp field from the time of arrival at the input, and adding the time that the packet is outputted from the node. The use of just one time stamp field reduces the overhead for the packet, but only by introducing an additional time processing step at the node input which in turn adds complexity.

#### Disclosure of the Invention

An object of the present invention is to provide a packet transmission system in which variable delays can be measured more simply than in the known systems.

This is achieved according to the invention by measuring the time which each packet spends in an output queue of each node and adding this time to a time stamp field of the packet. The invention assumes that the delay between the arrival of a

packet at the input node and the arrival of the same packet in an output queue is substantially fixed, or at least varies by a negligible amount compared with the time spent in an output queue.

#### Description of the Drawings

The invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a schematic diagram of a packet switching network,

Figure 2 is a schematic diagram of a packet switching node as used in the network of Figure 1,

Figure 3 is a diagram of marker signals used in the node of Figure 2, and

Figure 4 is a diagram showing the format of a packet within the node of Figure 2.

#### Mode of Carrying Out the Invention

The packet switching network illustrated schematically in Figure 1 comprises a plurality of interconnected packet switching nodes 1 some of

which have input/output terminal devices 2, connected to them so that they can communicate with one another via the network. Data is transferred between the terminals 2 in the form of packets within a frame format known as frame relay. Each packet has a header including a logical address field by means of which it is routed through the network. Each node refers to the logical address field in order to select the appropriate output to which to route it. As shown in Figure 2, each node includes a number of input buffers 3 to receive incoming packets and transfer these to appropriate output buffers 4 via a parallel bus 5 under the control of input and output controllers 6 and 7.

The bus 5 is 8 bits wide and packets are transmitted on it in 8 bit bytes within the slots of a time frame defined by a 4 kHz frame marker signal  $S_{FR}$  generated by a clock 8 and applied to a clock line 9 of the bus. Typically, each frame is divided into 6144 time slots, and all of the input and outputs to the bus are synchronised to this slotted frame format by reference to the frame marker signal  $S_{FM}$  as shown in Figure 3. The input controller 4 controls the allocation of the time

slots for the transmission of packets across the bus, and allocates pairs of consecutive slots,  $M$  and  $M + 1$  being a typical pair, for the transmission of each packet so that a multiple of 16 bits is transmitted per frame at a rate of 4 kHz. The output controller 7 shares the slot allocation information with the input controller 6, and controls the receipt of packets from the bus by the output buffers 4, 4', as described hereinafter.

Each incoming packet is processed in an input buffer 3, 3' and, as applied to the bus 5, has a header  $H$  with a plurality of information fields shown in Figure 4, including an address field  $AD$ , a priority field  $PR$  and a time stamp field  $TS$ . The address field  $AD$  contains a logical address  $LA$  derived from the incoming packet and a bus address  $BA$  which is added in the input buffer 3 under the control of the input controller 6 and corresponds to the address of one of the output buffers 4 or 4' through which the packet is to be routed to the next node 1 or a terminal device 2. Every time a packet from an input buffer 3 or 3' is applied to the bus 5, the input controller 6 applies a packet address marker  $S_{PA}$  to a control line 10 of the bus



to coincide with the address field AD in the packet header. This control line 10 is connected to the output controller 7 which responds to the packet address marker  $S_{PA}$  by causing all of the output buffers 4, 4' to read the address field of the associated packet. That output buffer 4 or 4' which recognises the bus address BA as its own, is triggered to receive the whole of that packet, which it then passes to a corresponding output packet store 11 or 11' after removing the bus address from the address field.

Each output packet store 11, 11' comprises a buffer which stores the packets it receives in a plurality of FIFO queues each corresponding to a different priority level of the packets. This priority level is identified for each packet by reference to the priority field PR in the packet header which has been added in the input buffer 3 or 3' under the control of the input controller 6 and is deleted once the packet has been directed to a queue. A packet controller 12 controls the order in which the queues are accessed to transfer packets to the output of the store for transmission onwards via a respective line controller 13, 13'. The frequency with which each

queue is accessed depends on the priority level of that queue, although any particular queue can be given absolute priority over all others if required, so that this queue is emptied before any of the other queues are accessed.

Considering time delays in the transmission of any packet across the node, there is a minimal variable time delay in the transmission of the packet between the input of the input buffer 3 and input of the output packet store 11. The input buffer 3 only has a limited capacity sufficient to buffer the incoming packet data to adapt it for application to the bus, and this delay is fixed. The bus 5 involves a transmission delay corresponding to a possible timing difference between the arrival of a packet and the occurrence of the next allocated pair of time slots. At maximum, this delay equals the period between successive pairs of time slots, which for a 4 kHz frame marker signal  $S_{FR}$  has a maximum value of 250 microseconds. The output buffer 4 operates to receive a complete packet before this is transferred to the output packet store 11, and this incurs a delay corresponding to the packet size. Thus, for any packet switch connection,

there is a maximum variable delay time for the transmission of a packet through the node to the output packet store.

The delay incurred in the output packet store 11 is variable and depends upon the priority level of each packet and the length of the corresponding queue to which it is allocated. Under normal operating conditions, this delay is long compared with all other possible variable delays.

The time stamp field TS in the header of each packet is used to provide an accumulative value of the variable transmission delays incurred by a packet in the network. The packet controller 12 includes a timing function represented as 14 in Figure 2 which serves to measure the time each packet spends in a queue of each output packet store 13, 13', and adds this time to that recorded in the time stamp field TS of the packet header before the packet is outputted from the store.

## CLAIMS

1. A method of measuring the transmission delay of a packet in a network of one or more nodes comprising measuring the time which the packet spends in an output queue of each node and adding this time to a time stamp field of the packet.
2. A packet transmission system comprising a network of one or more nodes each comprising a number of inputs connected via packet switching means to a number of outputs each of which has storage means associated with it in which to store a queue of packets to be outputted; characterised in that each node is provided with timer means to measure the time each packet spends in a queue of said storage means; and stamping means to add to a time stamp field of each packet before it is outputted from the node, the time the packet has spent in a queue as measured by the timer means.
3. A method of measuring the transmission delay of a packet in a network substantially as herein described with reference to the accompanying drawings.
4. A packet transmission system substantially as

herein described with reference to the  
accompanying drawings.

**Examiner's report to the Comptroller under  
Section 17 (The Search Report)**

9124914.4

**Relevant Technical fields**

(i) UK CI (Edition K ) H4P (PPS) ; H4K (KTK)

(ii) Int CI (Edition 5 ) H04L 12/56

**Databases (see over)**

(i) UK Patent Office

(ii) ONLINE WPI, INSPEC

**Search Examiner**

K WILLIAMS

**Date of Search**

27 MARCH 1992

Documents considered relevant following a search in respect of claims 1, 2

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
A	GB 2177877 A (STC) see Claim 1	1, 2
A	EP 0234860 A2 (ATT) see figure 11, page 27 and Claim 1	1, 2
A	WO 84/00268 A1 (WESTERN ELEC.) see pages 71, 72	1, 2

Category	Identity of document and relevant passages	Relevant to claim(s)

**Categories of documents**

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| <p><b>X:</b> Document indicating lack of novelty or of inventive step.</p> <p><b>Y:</b> Document indicating lack of inventive step if combined with one or more other documents of the same category.</p> <p><b>A:</b> Document indicating technological background and/or state of the art.</p> | <p><b>P:</b> Document published on or after the declared priority date but before the filing date of the present application.</p> <p><b>E:</b> Patent document published on or after, but with priority date earlier than, the filing date of the present application.</p> <p><b>&amp;:</b> Member of the same patent family, corresponding document.</p> |
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